FRANKFORD AVENUE BRIDCE OVER POQUESSINC CREEK
Pennsylvania Historic Bridges Recording Project
Spanning Poquessing Creek at Frankford Ave. (U.S. Rt. 13)
Philadelphia
Philadelphia County
Pennsylvania

HAER No. PA-471

PHOTOCRAPHS

REDUCED COPIES OF MEASURED DRAWINGS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

HISTORIC AMERICAN ENGINEERING RECORD
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HISTORIC AMERICAN ENGINEERING RECORD

FRANKFORD AVENUE BRIDGE OVER POQUESSING CREEK

HAER No. PA-471

Location:	Spanning Poquessing Creek at Frankford Avenue/Bristol Pike (U.S. Route 13), between Philadelphia, Philadelphia County, and Cornwells Heights, Bucks County, Pennsylvania.
USGS Quadrangle:	Beverly, New Jersey-Pennsylvania (1966, photorevised 1973).
UTM Coordinates:	18/501600/4434730
Date of Construction:	1904.
Designer:	George S. Webster, chief engineer; Henry H. Quimby, assistant engineer.
Builder:	John McMenamy.
Present Owner:	Pennsylvania Department of Transportation.
Present Use:	Vehicular bridge.
Significance:	This single-span, closed-spandrel arch bridge is an early example of a concrete bridge with supporting steel members. The bridge's exterior is made to appear like stonework, with scoring on the spandrel walls and delineation of voussoirs around the arch ring. The bridge parapet features decorative urn-shaped balusters, a design feature that became common for concrete bridges in parks and cities in the early part of the twentieth century. The Frankford Avenue Bridge was listed in the National Register of Historic Places in 1988.
Historian:	J. Philip Gruen, August 1997.
Project Information:	This bridge was documented by the Historic American Engineering Record (HAER) as part of the Pennsylvania Historic Bridges Recording Project - 1, co-sponsored by the Pennsylvania Department of Transportation (PennDOT) and the Pennsylvania Historical and Museum Commission during the summer of 1997. The project was supervised by Eric DeLony, Chief of HAER.

The nineteenth century was a period of rapid change for American bridge engineering. Patents were frequently granted for new designs, new trussing systems, and new modes of construction. Materials and types came and went; change was imminent, obsolescence rapid. By 1900, the wooden timber crossings of streams and rivers of the early nineteenth century were but a distant memory, most long since washed away or burned, replaced by massive structures of iron and steel able to support huge locomotives pulling fifty-car trains.

The unadorned steel bridges that were commonplace by the late nineteenth century had ushered in an entirely new age of bridge design and construction. Yet Americans were initially resistant to their industrial look and feel. These steel bridges, often with little or no ornamentation, were also greatly susceptible to rust and, at times, fire.

By the late nineteenth century, news of an invention involving a seemingly new type of material — concrete — had trickled over from France. American engineers were fascinated by the compressive strength it could provide; they knew, too, that if the concrete could be somehow combined with steel, bridges could be built that would be both structurally sound and essentially fireproof.

By 1900, a handful of small concrete bridges employing steel members had been erected in the midwestern United States. Yet the new technology remained largely unexplored in the eastern part of the country, although it was there that many of the new ideas in bridge-building technology were initiated during the nineteenth century.[1]

However, in 1904, the city of Philadelphia, together with Bucks County to its north, erected a single-span, 71'-0" barrel arch bridge of concrete and steel between Frankford Avenue and Bristol Pike over Poquessing Creek. It was among the earliest concrete bridges east of the Mississippi to use steel supporting members, and its decorative, um-shaped balustrade, and masonry-like facade mark an important point in the history of bridge engineering, when the appearance of raw concrete was apparently too new to exist without reference to more familiar materials.

The Frankford Avenue Bridge was also erected during a short-lived period, from about 1895 to 1910, when most early concrete and steel bridges featured closed-spandrel arches. The closed-spandrel arch form began to decline earlier than 1910, however. In 1906, engineers built a single-span reinforced concrete bridge over Unami Creek near Milford Square in Bucks County, Pennsylvania, and felt confident enough to punch openings through its spandrel walls. This allowed the steel to perform more of its intended function, and lessened the overall amount of concrete.[2] Just one year later, a graceful, multiple-span reinforced concrete arch bridge with open spandrels was erected in Washington, D.C.'s Rock Creek Park. By 1910, the brief era of

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[1] Carl Condit, *American Building Art: The Nineteenth Century* (New York: Oxford University Press, 1960), 224.

[2] The bridge, known as Campbell's Bridge, may be the nation's earliest open-spandrel reinforced concrete arch bridge. See U.S. Department of the Interior, Historic American Engineering Record (HAER), No. PA-451, "Campbell's Bridge," 1997, Prints and Photographs Division, Library of Congress, Washington, D.C.

the closed-spandrel concrete arch bridge was effectively over, as bridge engineers confidently used minimal amounts of steel for the construction of lighter-appearing and, quite often, more impressive-looking bridges.

Articulated Concrete

The growing familiarity with the technological properties of concrete, however, did not eliminate the perceived need to hide the concrete from view by facing it in stone or by decorating it to resemble other, more familiar, materials. In urban areas and parks throughout the country during the late nineteenth and early twentieth centuries, in fact, bridges were carefully articulated to the point where aesthetic considerations seemed the equal of structural concerns.

A number of developments may have contributed to this trend. In the 1860s, Calvert Vaux and Jacob Wrey Mould arguably set a precedent for urban park bridges with four lavishly decorated cast-iron spans in New York City's Central Park. By the turn of the century, architects and planners were also adopting ideas emerging from Chicago's 1893 World's Columbian Exposition, which arguably spawned the "City Beautiful" movement. This movement was supported — and in a certain sense, actually generated — by the progressive politics of civic leaders nationwide. This resulted in the construction of parks, playgrounds, and recreation areas thought to contribute to social welfare.

Most of the small spans in urban parks and over streams in urban areas at the turn of the century, however, were built of wood or stone. These bridges, in part because of their natural materials, blended comfortably with their natural surroundings. The structural limitations of these materials, however, often necessitated their replacement. Although concrete provided strength and lessened the overall amount of material, it was still common to articulate bridges made with this material to resemble that of their predecessors.

Because many of the first concrete arch bridges were of the plain (unreinforced) variety and resembled their masonry predecessors in arch form, they were often faced with stone.[3] Many of the large stone railway viaducts of the mid-nineteenth century, for example, combined concrete and masonry construction. Frequently, plain concrete was used as a principal building material while spandrel facing and voussoirs were executed in stone.

In its plain form, however, concrete did not resemble any material familiar to the American public. Few, if any, early concrete bridges — with or without steel — were left unarticulated. For example, Ernest L. Ransome's 1889 Alvord Lake Bridge in San Francisco's Golden Gate Park (considered America's earliest reinforced concrete arch bridge), was not faced in masonry but articulated to resemble it, with two layers of voussoirs, a rough finish, and strips of concrete in the form of stalactites hanging from the ceiling. This 20'-0" single-span bridge consists of twisted iron bars embedded longitudinally in the concrete of the soffit and bent to form the curve of the arch. This system had no immediate successors.

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[3] Condit, 246.

Concrete and Steel

Four years later, southeast of the Frankford Avenue Bridge, what may have been the first concrete and steel bridge on the east coast and the second in the United States was erected along Pine Road over Philadelphia's Pennypack Creek (1893-94). The Pine Road Bridge was a two-span structure with arches of 25'-5" and wire mesh acting as a binding element rather than as reinforcing. This system resembled that patented by Joseph Monier, who pioneered the use of wire mesh as a reinforcing agent in Paris in 1861. The bridge's exterior, like that of the Frankford Avenue Bridge, was made to resemble masonry.

In 1904, the system of concrete reinforcing patented by Viennese engineer Joseph Melan was the most popular method for concrete arch bridge construction in America. Put into widespread practice by German-born engineer Fritz von Emperger in the 1890s, the Melan system included a series of parallel iron or steel I-beams curved to the profile of the soffit. Emperger developed some variations on this theme, for which he received a U.S. patent in 1897.

One of these variations involved the addition of steel diagonal members running the length of the arch between the parallel I-beams. This system required a large volume of steel, and it was not long before new methods were devised to reduce the overall amount. At this early stage, however, engineers were not willing to risk structural failure with still largely untested systems. It is this essential variation of the Melan system that was adopted by Philadelphia city engineers George S. Webster and Henry H. Quimby for the design of the Frankford Avenue Bridge.

A number of projects, both major and minor, were carried out under Webster's engineering supervision throughout his tenure as chief engineer in the Bureau of Surveys in Philadelphia's Department of Public Works.[4] Included among these were the 233'-0" clear-span Walnut Lane Bridge (1906-08) over Wissahickon Creek in Philadelphia's Fairmount Park, one of the nation's earliest open-spandrel concrete arch bridges, and its longest for a time. Webster and Quimby together were in charge of the initial design for the Henry Avenue (Wissahickon Memorial) Bridge (HAER No. PA-464), also in Fairmount Park, and Webster was retained as a consultant when Ralph Modjeski was put in charge of the final design some sixteen years later.

The King's Highway Bridge

The first bridge to span the Poquessing Creek site was erected in the late seventeenth century. As part of one of the "King's Highways" connecting Philadelphia to Bristol, New Jersey, a bridge was built "over portquessing Creek" following orders given by the Provincial Council of Pennsylvania on 10 June 1697. The "portquessing Creek" bridge — a two-span structure of stone construction — was jointly funded by Philadelphia and Bucks County, just as

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[4] Webster spent many years in Philadelphia's Department of Public Works. After a brief stint as an assistant engineer, he became chief engineer on February 1, 1893. He remained in this position until 1915, and later served on the board of engineers in charge of construction for the Delaware River (Benjamin Franklin) Bridge, erected in the 1920s.

the Frankford Avenue Bridge was more than 200 years later.[5] Delegates from Massachusetts to the First Continental Congress are thought to have crossed this bridge in 1774 after they dined at the Red Lion Inn, located just across Poquessing Creek in Bucks County.[6] It was built in conjunction with other bridges along the highway in the late seventeenth and early eighteenth centuries.[7]

As early as 1803, the King's Highway became part of the Frankford and Bristol Turnpike, one of the nation's earliest toll roads. The area around the bridge on the Bucks County side gained notoriety in the early nineteenth century because of the construction of Nicholas J. Biddle's Andalusia estate along the Delaware River, which became a social center for Philadelphia elite.

In 1892, the Frankford and Bristol Turnpike Company sold the road to the city of Philadelphia, after which point the road — at least on the Philadelphia side — became known as Frankford Avenue. The Frankford and Southwark Trolley Company formed by 1893, and on 3 October 1895, the first trolley went into service between Cedar Hill (Frankford Avenue and Bridge Street) and Poquessing Creek.[8] Development around the bridge site was largely scattered before the turn of the century, but the extension of the trolley and the demands of highway traffic eventually necessitated the construction of a wider bridge over the creek.[9]

Planning a New Bridge

Money for a new bridge, to be funded jointly by Philadelphia's Department of Public Works and Bucks County, was set aside on 30 December 1901, and the first plans and specifications were drawn up in 1902. Proposals for the bridge were received on 20 September

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[5] *Minutes of the Provincial Council of Pennsylvania: From the Organization to the Termination of the Proprietary Government* (Philadelphia: Joseph Severns and Company, 1852), 1:514 (10 June 1697).

[6] John T. Faris, *Old Roads Out of Philadelphia* (Philadelphia: J. B. Lippincott Company, 1917), 299.

[7] "Frankford Avenue over Poquessing Creek," folder 630, photographic collection, Philadelphia City Archives, Philadelphia, Pennsylvania. In 1683, a law was passed authorizing the construction of bridges over all the smaller creeks and rivers along the King's Highway. The only extant bridge built in accordance with this law is a stone arch bridge over Philadelphia's Pennypack Creek, about one mile south of the Poquessing. That bridge (HAER No. PA-465) is the oldest surviving roadway bridge in America.

[8] I. Person Willits, "The Pennypack in Lower Dublin Township," in *Philadelphia History: Papers Read Before the City History of Philadelphia* (Philadelphia: History Society of Philadelphia, 1917), 215.

[9] A city map from 1910 shows only a few buildings, including a police substation and a "pleasure park" in the vicinity of the bridge. Most of the land was owned by Edward de V. Morrell, Louise D. Morrell, and Catherine M. Drexel. See George W. Bromley and Walter S. Bromley, *Atlas of the City of Philadelphia From Actual Surveys and Official Plans* (Philadelphia: George W. Bromley and Walter S. Bromley, 1910), plate 52.

1902, but the Bucks County Commissioners refused to proceed because the proposals all exceeded the original estimates.[10]

Eventually, however, the plans were authorized by a Philadelphia "Ordinance of Councils" on 29 December 1902, and the drawings for the bridge were approved in July and August of 1903. Bids for construction were received on 18 September 1903, and John McMenamy, with a low bid of $12,800.00 and recent experience with sewer construction for the Philadelphia Department of Public Works, was awarded the contract to build the bridge on 24 September 1903. McMenamy was given five months from the date of notice to complete the bridge.[11] Construction began on or about 9 November 1903, and a temporary wooden bridge to the north of the site was erected for passage during construction.

The contract for erecting the new concrete and steel bridge also included removal of the old stone structure, although the specifications included a "special clause" that allowed for stones from the old bridge to be included in the foundations and abutments. This clause included instructions for the erection and removal of the temporary bridge, the mixture and placement of the concrete, and placement of steel.[12] In addition, existing streetcar tracks had to be removed. Most of the specifications, however, complied with the "General Provisions and Conditions" adopted by the Philadelphia Department of Public Works.

Frankford Avenue Bridge Details

As built, the single-span, closed-spandrel arch bridge has a length of 71'-0" between abutments, a 16'-6" rise from the base of the abutments to the arch crown, and a total length of 119'-0".[13] The single-centered span is constructed of a high-aggregate concrete made of one part cement, two parts sand and gravel, and five parts crushed stone surrounding five parallel rows of 3/4" square or 7/8"-diameter round steel rods. Each of these rods is 25'-0" long on each side of the arch, and between them are riveted steel diagonals of the same width. This steel truss-like arch has bolted connections and is covered by 3" of concrete on both sides.

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[10] Philadelphia Department of Public Works, *Fourth Annual Message of Samuel H. Ashbridge, Mayor of the City of Philadelphia, with Annual Reports of William C. Haddock, Director of the Department of Public Works and of the Bureau of Surveys for the Year Ending December 31, 1902* (Philadelphia: Dunlap Printing Company, 1903), 146.

[11] Philadelphia, City of, and Bucks County, "Agreement Between City of Philadelphia, Bucks County, and John McMenamy," 24 September 1903.

[12] Philadelphia, City of, and Bucks County, "Specifications for the Construction of a Concrete Steel Arch Bridge on the Line of Frankford Avenue, formerly Frankford and Bristol Turnpike, over Poquessing Creek Between the City of Philadelphia and Bucks County," 1903.

[13] The 71'-0" length is indicated on the "as built" plans. A 1986 report by A. G. Lichtenstein and Associates, Inc., however, lists the length at 73'-0". See Richard J. Slattery, "Bridge Inspection Report: Frankford Avenue over Poquessing Creek," 31 July 1986 (Bridge inspection file, BMS No. 67-0013-0300-3108, PennDOT District 6-0, Saint Davids, Pennsylvania).

The concrete of the arch ring was laid continuously in transverse sections to avoid longitudinal joints. The concrete and steel abutments reach a maximum length of 16'-0" on either side and are over seven feet high. Concrete in these abutments is composed of one part cement, three parts sand or gravel, and six parts crushed stone. The arch has an under clearance of 13'-3" to the creek bed.

The substructure supports a deck that is 119'-0" long (including two 24'-0" approaches), with a clear roadway of 40'-0" between curbs and an approximate deck width of sixty feet between parapets, including two large, approximately eight-foot-wide sidewalks. The roadway is supported by a bed of concrete reinforced with 3/4" plain steel bars running longitudinally. On either side of the deck are decorative parapets made of urn-shaped balustrades, each 38" tall with 7/8"-diameter round steel rods. Eight large concrete newels separate every eleventh baluster on each side, each 3'-6" in length except for those over the main piers, which are 4'-7" and include the plaques listing the principal parties involved in the bridge's construction. The decorative balustrade was a late addition to the plans, which had apparently first called for a parapet of different design.[14]

The spandrel walls were scored to resemble stone and the vertical faces of the arch ring were also scored to simulate voussoirs. While much of the bridge's underside was left unornamented, a layer of concrete along the base of the arch near the abutments — visible only to those underneath the bridge — was also articulated to resemble masonry. Interestingly, the balusters and newels — the most visible parts of the bridge — were left unscored.

While the variety of factors making ornamentation of bridges in parks and urban areas popular at the turn of the century may have inspired the design of the Frankford Avenue Bridge, the engineers may have also been influenced by the then-extant three-span stone arch bridge no more than forty feet away to the northeast over a bend in Poquessing Creek. Upon its completion, Webster wrote that the "whole structure is graceful in appearance and forms an attractive feature of the landscape," noting that its reinforced concrete construction provided the added benefit that the bridge would never need painting and that the only maintenance ever required would be to the roadway.[15]

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[14] Philadelphia Department of Public Works, Bureau of Surveys, Bridge Division, "Bridge on Frankford Avenue over Poquessing Creek: Design for Reinforced Concrete Balustrade," 2 April 1904 (Drawing No. 8374, Compartment No. 7).

[15] Philadelphia Department of Public Works, *Second Annual Message of John Weaver, Mayor of the City of Philadelphia with the Annual Reports of Peter E. Costello, Director of the Department of Public Works and of the Chief of the Bureau of Surveys for the Year Ending December 31, 1904* (Philadelphia: Dunlap Printing Company, 1905), 11.

The bridge was noted as complete on 7 November 1904.[16] Its final cost, including money for extra concrete in skewbacks and inspections of the metal and masonry, came to $13,256.00, with Philadelphia and Bucks County each paying $6,628.00. An approach to the bridge on the Philadelphia side, not included in the original bridge contract, was also completed by McMenamy on 22 November 1904, for $3,127.59. This was paid for entirely by the city of Philadelphia.

Photographs taken less than one month after construction show that one line of streetcar tracks had been laid and trolleys were already crossing the bridge. A sign on the southeastern side of the bridge noted that the Philadelphia, Bristol, and Trenton Railway Company now offered direct runs to Bristol, connecting there with cars for Tullytown, Morrisville, Trenton, New Town, Langhorne, and Doylestown. Buildings on both sides of the bridge displayed cigar advertisements, and one of them, on the southwestern side of the bridge, included a prominent advertisement for chewing tobacco.[17]

The Frankford Avenue Bridge over Poquessing Creek was merely one among many early Philadelphia concrete bridges to be faced in stone or scored to resemble it; a number of these were built throughout the 1900s, and as late as 1921, a single-span reinforced concrete bridge was built over the Poquessing on line of Bensalem Avenue with a facade of rubble masonry and a rubble parapet to "make the bridge architecturally in keeping with its surroundings."[18]

Through the Years

Throughout the twentieth century, the Frankford Avenue Bridge has required only occasional maintenance — and most of it to the roadway, as Webster correctly predicted. In 1937, an act of Congress made the bridge part of a defense highway as Frankford Avenue was declared a Federal Aid Route. In 1947, repairs were made to the curbs, sidewalks, and a section of the arch soffit on the downstream side of the bridge. Recent inspections revealed highly exposed aggregate, some hairline cracks on the underside of the arch barrel, and some efflorescence due to leakage. Several of the balusters show exposed reinforcing bar and one, on the western side of the bridge, is missing entirely.

That a railing of similar design was adopted as a standard type by many municipal public works departments and state highway departments in the 1920s and 1930s is testimony to the

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[16] The bridge was probably completed in April or May of 1904, but the final payment was not issued until 7 November 1904. See Philadelphia Department of Public Works, Bureau of Surveys, *Record of Bridges* (Philadelphia Streets Department, Municipal Services Building, Philadelphia, Pennsylvania).

[17] "Frankford Avenue Bridge over Poquessing Creek."

[18] Philadelphia Department of Public Works, *Annual Report of the Bureau of Surveys of the City of Philadelphia for the Year Ending December 31, 1921* (Philadelphia: Dunlap Printing Company, 1922), 35.

lasting influence of this early period of reinforced concrete construction.[19] The Frankford Avenue Bridge stands today as a reminder of an important moment in the history of American engineering and technology — when the properties of steel and concrete construction were being worked out and when the appearance of unarticulated concrete was still too jarring to be left in its raw state.

[19] The state of Texas, for example, adopted the urn-shaped balustrade as one of its standard railings in the 1930s. A number of bridges in Houston, too, were built with this feature over Buffalo Bayou and White Oak Bayou in the 1920s. See U.S. Department of the Interior, Historic American Engineering Record (HAER) No. TX-40, "White Oak Bayou Bridge," 1996, Prints and Photographs Division, Library of Congress, Washington, D.C.

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APPENDIX: Suggestions for Further Research

Some questions concerning the Frankford Avenue Bridge arose during the research and writing of this report. Some of these questions, due to limitations in the scope of the Pennsylvania Historic Bridges Recording Project - I, remain unanswered. It is suggested that scholars interested in this bridge consider pursuing the following:

1. Was the Philadelphia Department of Public Works influenced by nationwide urban beautification trends at the turn of the century?

2. Was George S. Webster, chief engineer for Philadelphia's Department of Public Works, aware of Fritz von Emperger's variation of the Melan patent, or did he develop his method of reinforcing independently?

3. When was the stone arch bridge just to the northwest of the Frankford Avenue Bridge built? Did its presence influence any part of the new design?